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INSTITUTE FOR DEFENSE ANALYSES

Assessing Weapon System Acquisition Cycle Times: Setting Program Schedules

Richard H. Van Atta, Project Leader
R. Royce Kneece, Jr.
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Rachel D. Dubin

The Institute for Defense Analyses is a non-profit corporation that operates three federally funded research and development centers to provide objective analyses of national security issues, particularly those requiring scientific and technical expertise, and conduct related research on other national challenges.

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Executive Summary

This paper is a progress report on research undertaken by the Institute for Defense Analyses (IDA) to better understand Major Defense Acquisition Program (MDAP) cycle times—i.e., the amount of time it takes to develop, produce, and field a new weapon system. This project is the second phase of research into the determinants of MDAP cycle time, including how program schedules are originally set, and subsequently how they are managed, to provide timely capabilities to Department of Defense (DOD) forces. The initial phase of this research, completed in 2014, reviewed prior research into issues associated with defense acquisition cycle times and defined a program of additional research, focused as follows:

1. **Acquisition schedule development**: How are schedules for acquisition programs actually set and how are they changed? What role does the requirements community play in the process?

2. **Management and oversight**: How are program managers incentivized to manage and control schedules? Once an acquisition program is established, what role does the requirements community play in decisions affecting program schedules?

3. **Program definition and characteristics**: Which types of systems or programs are associated with which problems? Are there indications of the root causes from a commodity perspective?

This second phase addressed the first of those topics, requirements definition and acquisition schedule development. Another related IDA task, conducted concurrently with this task, explored the third topic by examining the historical trends in MDAP cycle times by program commodity or type, and growth in those times over the course of the programs' development, production, and initial fielding. Findings of that task will be drawn upon in defining the context for the current work.

Approach

To determine how schedules are set, the study team reviewed both requirements system and acquisition system documentation on the schedule-setting processes and conducted interviews with personnel in both the requirements communities and acquisition communities. In coordination with the sponsor, the team selected a small set of MDAPs for in-depth investigation

of the drivers that determined schedule benchmarks. The team sought to determine: the inputs and analytical processes the requirements community used to set times when capabilities are needed and how those parameters are ultimately used by the acquisition process to establish program schedules. During this process, the research team sought to identify examples of "best practices" for oversight and management of schedules.

Overall Perspectives

The interviews and document reviews resulted in the following overall perspectives regarding schedules and cycle time:

- Current requirements documentation does not facilitate tracking of how program schedules are set. There is little if any documentation of tradeoff analyses and negotiations regarding schedules between "requirers" and "acquirers"— informed by perspectives on the maturity of applicable technologies.

- There is little evidence that trades are made that reduce requirements in favor of accelerating schedules.

- Acquisition Schedules are driven by needs and processes:
  - *Needs*
    - New and evolving threats
    - Obsolescence and associated increased support costs
    - Changes in priorities or strategy—e.g., shift toward the Pacific region
  - *Processes*
    - Program/budget factors: execute programs within available funds
    - Technology maturation
    - Industrial base: keep something in the pipeline to maintain the industrial base
    - Acquisition management process constraints

Evaluation of Selected Programs

Based on guidance from the sponsor, programs were selected for in-depth examination that had been initiated within the last six years in order to more accurately reflect current processes:

- Army: Common Infrared Countermeasures (CIRCM) and Integrated Force Protection Capability (IFPC)

- Navy: Next Generation Jammer (NGJ) and Air and Missile Defense Radar (AMDR)

- Air Force: 3-Dimensional Expeditionary Long-Range Radar (3DELRR) system and F-22 Increment 3.2B Modernization

Specific Findings

Most of the programs examined are in response to requirements first stated in the 2004–2010 timeframe and most have IOC dates in the 2020+ timeframe. In most of these programs, requirements are near-term threat-driven, though obsolescence is also a factor. It is our observation that for these programs, the needed capabilities will be available *several years after the threats emerged. That is, the threats these programs are aimed to address either exist now or will emerge into operational reality before the systems are fielded.* That raises questions of how threats are defined and when they are seen as being realized. From that we conclude that *for some programs there appears to be a requirements–capabilities mismatch, where the problem appears to be that the technology needed will not be available at the time of the defined threat.*

The study arrived at the following more specific findings:

- Requirements inputs on IOC and other schedule parameters are difficult to pin down—documentation is lacking or difficult to obtain: For most current MDAPs, the IOCs reflected in acquisition documents were drawn from requirements documents drafted between Milestones A and B[1]—relatively late in process. Furthermore, it is not clear whether specified IOCs were based on need or what is achievable. Requirements documents for MDAPs are archived in the Knowledge Management and Decision System maintained on the SIPRNET[2] by the Joint Staff (J-8). That system has proven difficult to use and does not appear to contain all relevant documents.

- The team was not successful in obtaining several of the germinating requirements documents specific to systems reviewed. A clear statement was found for only one system (Air and Missile Defense Radar, AMDR) when specific threat capabilities were projected to be operational.

- Program schedule setting varies in rigor:

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[1] Up to the interim version of DODI 5000.02 published in November 2013—i.e., the one in effect when all the programs investigated were initiated. The current 5000.02 requires a draft Capabilities Development Document *prior to* Milestone A.

[2] Secret Internet Protocol Network

- – The Navy appears to have a well-defined process to initiate programs based on agreed understanding between "requirers," developers, and resource planners.

  - – The Air Force has a similar process but with a lesser role for resource planners.

- Focus on technology maturation as part of early acquisition strategy can be crucial.

  - – The AMDR and NGJ programs showed that technology-driven programs can be successful when attention is focused on earlier technology maturation. The CIRCM system is an example of the apparent failure to do that.

- Tradeoffs of performance, cost, and schedule: If it is deemed essential to meet firm schedule dates to support operational or other critical needs, it may be necessary to make tradeoffs of performance (especially in regard to the technologies employed) and/or costs in order to achieve the schedule needed. Although the current Department of Defense Instruction (DODI) 5000.02[3] contains several provisions requiring tradeoff analyses among cost, schedule, and performance, there is no explicit provision to consider the relative urgency of operational needs in making such tradeoffs. A more explicit statement would provide greater clarity. Changes may also be needed to Joint Staff procedures in order to identify such critical need dates.

- Funding impacts: It is difficult to discern causes from effects for funding reduction impacts on schedules.

  - – The only clear case identified in which funding issues caused program delay was NGJ, which incurred a double-hit for execution delays caused by award protest.

  - – Several programs appeared to lack priority in the program/budgeting process— 3DELRR, NGJ, CIRCM, IFPC. In the case of NGJ and CIRCM, that seems inconsistent with the need to counter near-term, or even current, threats.

- Process delays, such as protests, acquisition strategy reformulation, and contract rework have impacts, measured more in months than years, and they do not generally appear to be "long poles in tent" relative to other factors.[4]

Broader Insights

While much has been said and written on defense acquisition cycle time, often these thoughts do not include the obvious question: Why is there concern over acquisition cycle time? Arguably, reducing cycle time *per se* should not be the objective, since that may lead to a number of undesired outcomes, such as greatly increased costs and/or inadequate performance. At times it

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[3] Department of Defense Instruction 5000.02, "Operation of the Defense Acquisition System," January 2015.

[4] An exception might be the 3DELRR system, the subject of a protest and an associated ongoing lawsuit.

may be impossible to achieve stated performance requirements faster given the limitations of technology. Trading off the "required" performance to get something out quickly can have downsides—notably performance that falls short of meeting important operational needs. Rather the cycle time goal should be to structure and execute acquisition programs to best meet user needs in terms of both capabilities and timeliness. Though simply stated, achieving that end has many dimensions. It may not be technically possible to provide the capabilities desired by the user within the desired time constraint—in fact, in today's world of rapid technological dispersion, that situation might be the norm. So tradeoffs must be made to provide the best capabilities achievable by the time needed within an acceptable level of risk.

Thus in our view, the real "cycle time" issue is how to provide the operational forces weapon systems that have *the needed capabilities* and *that are fielded when needed.* To ensure that those dual objectives are met, it is necessary for requirements and acquisition communities to work together closely in the initial stages of systems acquisition to define programs based on technologies that can be matured and implemented in the required timeframe within an acceptable level of risk. If that process is not effectively accomplished, the ensuing program faces a high risk of failure to achieve its *fundamental objective* of providing the user the right capabilities at the right time.

For that process to work effectively requires rigorous assessments of the state of technologies, informed by technology prototyping, experimentation, and demonstration of advanced concepts, to assess the prospects and potential value to the user. Also, the maturation of underlying enabling technologies needs to be given adequate and sufficiently early focus and funding.

There is no "one size fits all" approach to achieving the fundamental objective stated above. At one extreme, there are rare situations where it is necessary to seek highly ambitious capabilities, accepting higher risks, to confront unknowns. Schedule and cost estimates will be more uncertain. It is the role of leadership to determine whether the requirements for such capabilities and their operational value justify taking on higher risks. The risks must be identified and articulated carefully to leadership so that an informed decision can be reached. Moreover, we contend that such ambitious and risky programs should be given direct and special management oversight and attention at the highest levels as a basis for their being undertaken.

At the other extreme are the "rapid acquisition" programs that meet immediate needs and therefore should be acquired using a low-risk, predictable approach with well-defined, currently available technologies. Those programs are usually not MDAPs though there have been exceptions—notably the Stryker and the Mine-Resistant Ambush Protected (MRAP) programs.

Most MDAPs fall between these extremes, and for most of them, getting it right is more important than getting it soon. Undue emphasis on cycle time and predictability of schedule can inhibit pursuit of programs that are aimed at difficult objectives that take more time to achieve. However, that does not mean being complacent in requiring those programs that aim high be well-founded on clear assessment of underlying assumptions regarding technical risk, and have a well-formulated program strategy to address that risk.

In those instances in which a program must reach for levels of performance that stress the state of art, then:

- The rationale in terms of future threat or compelling operational need should be clearly identified.

- Risks should be explicitly defined, independently verified, and made clear to all management levels.

    - There should be well-defined approaches pursued to reduce the risk by carefully maturing the technologies and addressing their integration into the system as the system evolves over time.

- The means for accommodating technology improvement and change into the system as it develops and is fielded overtime should be a clear part of the acquisition strategy.

- The program should receive high-level oversight throughout.

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I. Introduction and Research Focus

Current interest in acquisition program cycle times originated with the Under Secretary of Defense for Acquisition, Technology and Logistics (USD(AT&L)) Better Buying Power 2.0[5] initiative. Better Buying Power 3.0,[6] recently promulgated, continues an emphasis on program cycle times, but an even greater concern is that of the cycle time in technological innovation:

> Emphasize technology insertion and refresh in program planning. This initiative covers both the demand side (programs) and the supply side (science and technology projects). Because of the pace at which the technology associated with digital processing, radio frequency devices, optics, and networks (among others) is moving, the Department cannot hope to keep up using traditional acquisition approaches. We have to design our acquisition plans to account for periodic technology refresh cycles on a much faster time scale. In some cases, we may completely replace earlier versions of end products (e.g., some tactical radios), while in other cases, we must plan and design for periodic upgrades, sometimes while development is still in progress (e.g., F-35). In addition, we need to ensure that our early research and development (R&D) investments are aligned as much as possible with insertion opportunities in the products we are likely to acquire. This requires a tighter connection between our Science and Technology communities and our development programs.

It is clear from this extract that the concern is more than just the amount of time from concept to fielding of an acquisition program. It could be said that in Better Buying Power 3.0 time is of the essence—but specifically time to product is seen as highly related to technological capabilities.

The current task, shown in Figure 1, is focused primarily on how program schedules are established and executed, though our investigations have led to some insights into issues of broader concern regarding technology capabilities and user requirements.

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[5] Frank Kendall, Memorandum for Defense Acquisition Workforce, SUBJECT: "Better Buying Power 2.0: Continuing the Pursuit for Greater Efficiency and Productivity in Defense Spending" (Washington, DC: Department of Defense (DOD), November 13, 2012.

[6] Frank Kendall, Memorandum SUBJECT: "Implementing Directive for Better Buying Power 3.0—Achieving Dominate Capabilities through Technical Excellence and Innovation," (Washington, DC: Department of Defense, April 09, 2015.

Specific Tasks

In coordination with the sponsor, select a small set of programs for in-depth investigation of:

1. Requirements definition and schedules:
   – To what extent does the requirements process specify IOCs and FOCs in defining program requirements? When they are specified, what factors drive setting those benchmarks?
   – At what point in the acquisition process do schedule parameters get set? What role does the requirements community play in those decisions?
   – When programs miss scheduled milestones, what role does the requirements community play in adjusting the program?

2. Acquisition schedule development:
   – How are schedules for acquisition programs set and how are they changed? What are these schedules and changes based on?

Figure 1. Subtasks

II. Background

The term "cycle time" in reference to the defense acquisition system has been in use for many years.[7] However, we were unable to find an official definition of what is meant by "cycle time" in the context of an acquisition program. Better Buying Power 2.0 indicates that cycle time means the time "it takes to bring a product from concept to fielding."[8] This is consistent with a common understanding that the "cycle time" refers to the amount of time it takes DOD to field new capabilities, particularly MDAPs. More precisely, our research is taking cycle time to mean the time between the specification of a requirement for a military capability that entails a major system development, which normally is the Materiel Development Decision (MDD), and the time that such capabilities are fielded. As we will elaborate below, even this leaves room for some ambiguity, as both the start and end points can be elusive.

In particular when "cycle time" is used as a measure with specific values, interpreting those values depends on the measure's definition. The 2013 and 2014 DOD reports on the performance of the defense acquisition system do not state a definition, but it is clear from the text that cycle time is interpreted as the length of development contracts.[9] Even though that is clear, the report does not actually state what development contract is being measured, but the presumption is that it is the primary engineering and manufacturing development contract. A roughly equivalent, and easier to measure, definition is the time between Milestone B, the decision for a program to enter Engineering and Manufacturing Development (EMD), and achievement of an Initial Operational Capability (IOC).[10] Based on that measure, contrary to commonly held perceptions, acquisition cycle times have on average not been growing since 1980 (Figure 2).[11] However, as indicated in the figure, there is wide variation in results over programs. It is arguable that this is, of itself, not a problem, if program schedules are determined appropriately to meet operational requirements and if those schedules execute as planned. However, it is frequently the case that programs fail to meet their established

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[7] For example, the 1986 Packard Commission report stated that "…an unreasonably long acquisition cycle—ten to fifteen years for our major weapon systems. This is a central problem from which most other acquisition problems stem." *A Quest for Excellence*, Final Report to the President by the President's Blue Ribbon Commission on Defense management, June 1986, p.47.

[8] See http://bbp.dau.mil/bbp4focus.html.

[9] *Performance of the Defense Acquisition System*, 2014 Annual Report, Washington, D.C.: Under Secretary of Defense, Acquisition, Technology and Logistics, (USD(AT&L)), June 13, 2014.

[10] Obviously, both these measures will reflect cycle times that are much shorter than the ones suggested in the previous paragraph. See footnote 12 on page 6.

[11] Based on IDA analysis of data provided by OUSD(AT&L).

schedules. Figure 3 (which focuses on *"bad actors"*—programs executing more than 24 months behind schedule) shows that a substantial number of programs have had long delays in fielding.[12]
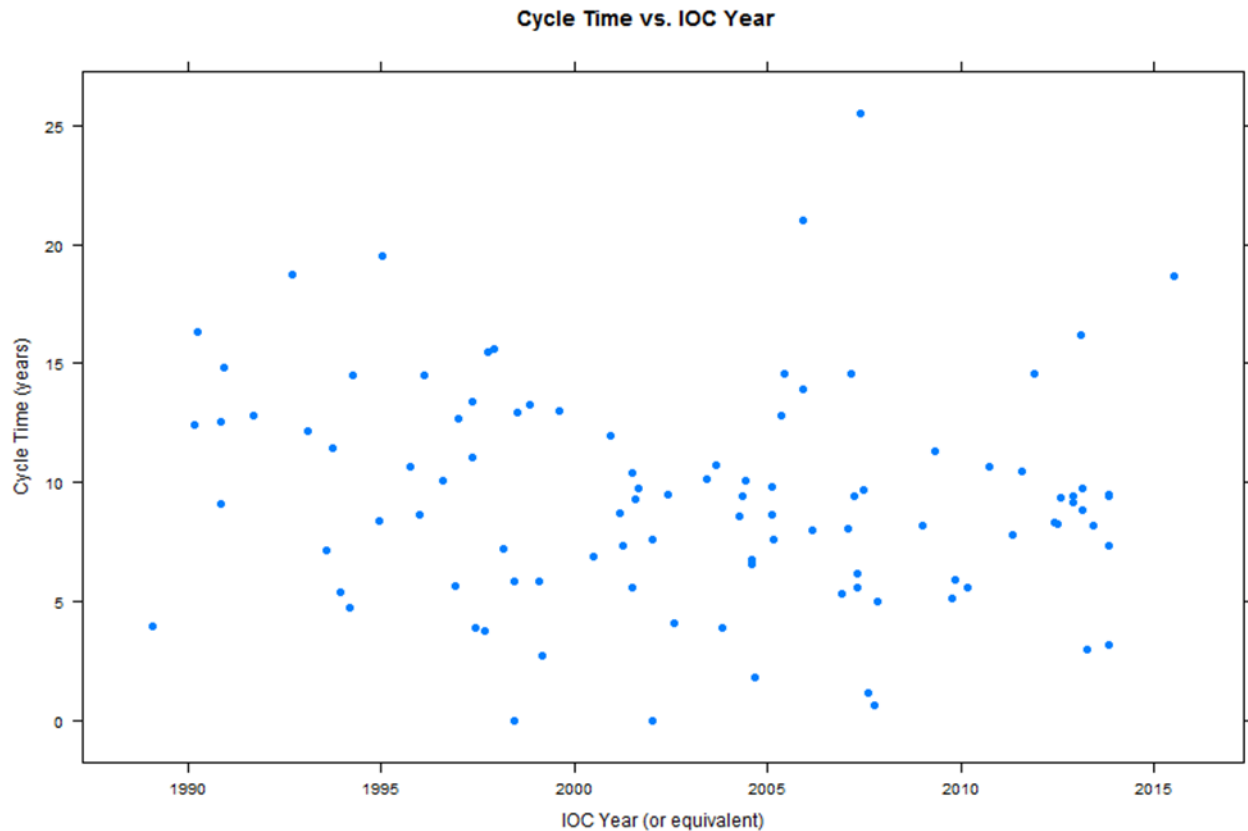
Figure 2. Time between Milestone B and Initial Operational Capability for MDAPs since 1980

Moreover, schedule growth is frequently accompanied by cost growth and in many cases is indicative of technology-related problems in development. An analysis conducted for the Office of Director, Operational Test and Evaluation, of the reasons for delay in 115 historical MDAPs revealed that delays usually have multiple causes; however, for 87 of the 115 programs, at least one cause of delay was a performance problem discovered during testing.[13] A reasonable (but unconfirmed) hypothesis is that many such performance problems had root causes in the technological solutions

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[12] The degree to which those delays caused operational problems has not been determined (and is not within scope of the present study).

[13] This analysis can be found on the Office of Director, Operational Test and Evaluation website at http://www.dote.osd.mil/pub/presentations/ProgramDelaysBriefing2014_8Aug_Final-77u.pdf

implemented in the programs—that is, the technological approach could not be realized within the time and cost estimates.[14]
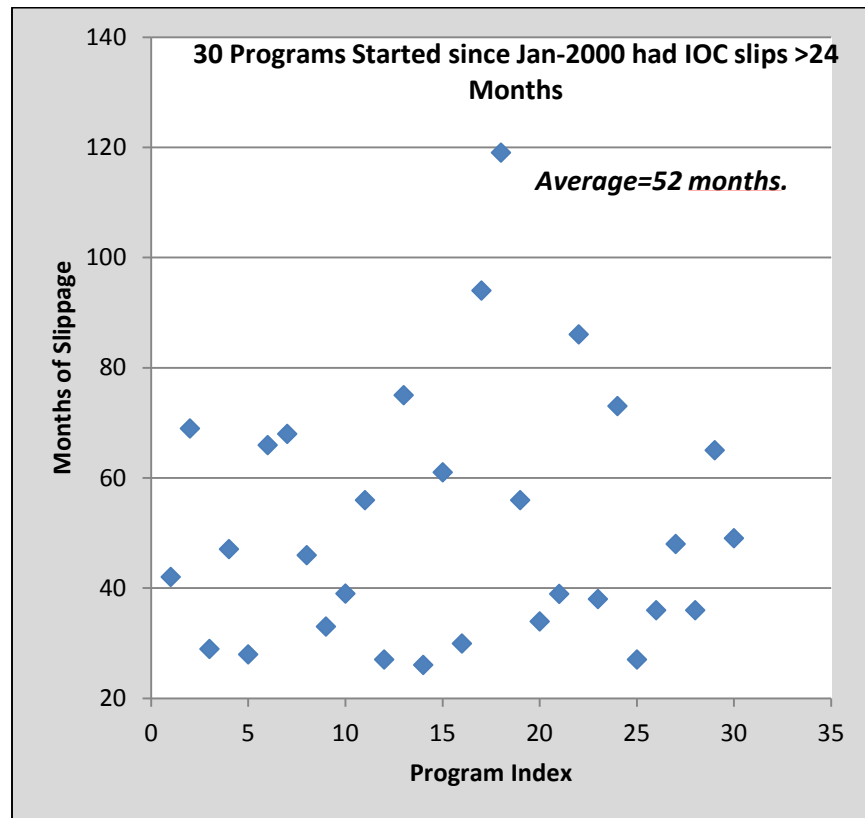
Figure 3. Defense Acquisition Programs from 2000, with Greater Than 24 Months Slippage

These data raise issues concerning program schedules that bear further assessment:

- **Many MDAPs are fielded significantly later than planned:**
  – What are the processes for establishing schedules in acquisition programs?

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[14] There is significant support for the hypothesis that ambitious programs that require development of crucial, high-risk advanced technologies to meet stressing performance objectives have had substantial program schedule delays. See for example, Riposo, McKernan, and Duran, "Prolonged Cycle Times and Schedule Growth in Defense Acquisition: A literature Review," The RAND Corporation, 2014, p. 15. Also, several PARCA "Root Cause" studies of MDAPs that had critical Nunn-McCurdy breaches cite technology readiness issues as a prime cause of cost growth, including ATIRCM, CMWS, Apache Block III, DDG-1000, and JTRS-GMR. (See Diehl, Richard, *et al*, *Root Causes of Nunn-McCurdy Breaches--A Survey of PARCA Root Causes Analyses 2010-2011*, IDA Paper P-4911, Alexandria, VA: Institute for Defense Analyses, August 2012.) (Most of those systems also experienced significant schedule growth.) More support can be found in the OT&E report, "Reasons Behind Program Delays: 2014 Update," (http://www.dote.osd.mil/pub/presentations/ProgramDelaysBriefing2014_8Aug_Final-77u.pdf) previously cited.

- To what extent are explicit tradeoffs between performance, cost, and schedule to meet required delivery dates?

- What are the consequences of delayed deliveries of capabilities?

- **MDAP schedule delays are characterized by wide variances and outliers, which may suggest major problems with certain types of systems.**

- **Acquisition programs that stretch the technological state of art often have impacts on schedule and cost.**

  - Presumably less ambitious capabilities could be delivered sooner and with less risk.

    - But, would those reduced capabilities meet operational needs, both near-term and longer-term?[15]

  - Thus the question of whether effective tradeoffs are made between schedule and capabilities (and if so, how and by whom?)

These issues became the basis for the present study.

A. Approach

Figure 4 is an overview of the "front-end" of the process for initiating an MDAP. The MDD is normally the formal entry point into the DOD acquisition process and the point at which programs are governed by the primary DOD acquisition process issuances, DODI 5000.02 and their DOD Component equivalents. That time is arguably the appropriate start point for an acquisition program[16] with IOC being the end point (though a case could be made for Full Operational Capability (FOC)).

While an MDAP's schedule is not engraved in stone until an Acquisition Program Baseline is established at the Milestone B entry into EMD, it is essential that firm ideas on schedule be set earlier—certainly by Milestone A entry into the Technology Maturation and Risk Reduction (TMRR) phase.[17] The technology selected at Milestone A must be sufficiently mature for a high probability of success in further maturation to the point where a producible engineering design can be developed at the end of the TMRR phase. The Initial Capabilities Document (ICD) must reflect a reasonably

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[15] If the answer is yes for near term but no for longer term, then an evolutionary acquisition approach is indicated.

[16] There are, however, several technical issues with this definition. One is that some programs bypass the MDD decision point and go directly to a Milestone A, Milestone B, or even Milestone C. A practical issue is that the MDD date is not systematically captured in an accessible database. Although the instructions for SAR preparation state that the schedule section should contain all major milestone decision points, *none* of the SARs checked contained any entries earlier than Milestone B.

[17] See Gene Porter, C. Vance Gordon, R. Royce Kneece, *Improving the "Front-End" of the DOD Acquisition Process*, IDA Paper P-4710, Alexandria, VA: Institute for Defense Analyses, June 2011, for an extensive discussion on initiation of MDAPs.

accurate understanding of what technologies can be sufficiently matured to provide the needed capabilities. Typically, a trade-off between the level of advancement of technologies and the operational needs must be made so that a program can be initiated that will be both successful and meet operational needs to the extent possible (such tradeoffs are indicated by the dotted arrows on Figure 4). An approximate, initial program schedule should be an output of that process.

How are Schedules Set for MDAPs? The Front-end is Crucial

Develop Requirements
Services, Joint Staff
- Capabilities Based Analyses (CBAs)
  - Threat
  - Combatant Commander priorities
  - Current/programmed capabilities
  - → Identify capability gaps (and when projected?)

Materiel Sol. needed → ICD → **Materiel Dev. Decision**

CDD

Iterate as needed

Analysis of Alternatives (AoA)
- Trade offs
  - Capability vs. cost
  - Capability vs. schedule
  (How are they made?)

Preferred Alternative

Technology Maturation/ Risk Reduction
- *Can technology required for preferred solution be developed and produced in time to meet required IOC?*

Milestone A

Figure 4. Process for Initiating Major Defense Acquisition Programs

The approach taken by this research is to:

- Determine how schedules are set by reviewing JCIDS[18] and acquisition system documentation on the schedule setting processes and by conducting interviews with personnel in both requirements communities (Joint Staff and Services) and acquisition communities (program managers, program executive officers, headquarters staffs)

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[18] Joint Capabilities Integration and Development System—The Joint Staff's process for review, approval of DOD Component initiation of new acquisition programs, and oversight of acquisition programs once launched.

- Coordinate with the sponsor to select a small set of MDAPs for in-depth investigation of the drivers that determined the schedule benchmarks specified in the initial requirements and acquisition documents

- For the programs selected, determine: 1) the inputs used to set times by which stated requirements are needed, 2) how those times affected the setting of program schedules, and 3) within the program management process, what information, analytical tools and decision criteria are used for setting, monitoring, and assessing schedules during program execution

- Identify programs/acquisition organizations that provide examples of "best practices" for oversight and management of schedules

B. Selecting Programs for Detailed Investigation

The study team reviewed the "universe" of recent and active MDAPs to identify good candidates for more detailed examination. The initial approach was to select a mix of both older, more mature programs and newer programs in order to address both questions about the ability of MDAPs to execute the schedules a well as questions about how schedules are established to begin with. This top-level screening is shown in Figure 5.

However, in an interim review with the sponsor, a greater focus on programs that began under the current acquisition team was requested, to establish a common timeframe with interest in more current versus "historical" programs. With that in mind, the following programs were selected:

1. Army:
   - Common Infrared Countermeasures (CIRCM)
   - Integrated Force Protection Capability (IFPC)

2. Navy
   - Next Generation Jammer (NGJ)
   - Air and Missile Defense Radar (AMDR)

3. Air Force
   - 3-Dimensional Expeditionary Long-Range Radar (3DELRR)
   - F-22 Increment 3.2B Modernization

The more current programs compared to the initial candidates are generally smaller scale and focused more on electronics and force protection systems with no major platforms. Since all of these programs are several years from IOC, we could not assess whether their schedules as established could actually be executed.

Service	Platform/ System Type	Time Phase of System								
		New (A>B)			Current (>B, but <IOC)			Fielded (IOC+)		
		Low-Tech Complexity	Medium-Tech Complexity	High-Tech Complexity	Low-Tech Complexity	Medium-Tech Complexity	High-Tech Complexity	Low-Tech Complexity	Medium-Tech Complexity	High-Tech Complexity
Army	Rotary Wing								AH-64E Apache	
	UAV								MQ-1C Gray Eagle	
	Ground Systems	AMPV				PIM				
	Electronic					CIRCM				
	Munitions/Missiles					IFPC			Excalibur	
Navy	Fixed Wing- Large Aircraft									E-2D
	UAV			UCLASS			MQ-4C Triton			
	Ships				SSC	LCS				
	Radar/Electronic		NGJ	AMDR						
	Munitions/Missiles								AGM-88E	
Air Force	Large Aircraft				KC-46A					
	Combat Aircraft						F-22 Incr 3.2B			
	UAV									MQ-9 Reaper
	Satellites/ Space/C3I			3DELRRS			FAB-T			WGS
				SBIRS Follow-on						
	Munitions/Missiles		HTM							
				GBSD						
Joint	Combat Aircraft						F-35			
	Ground Systems				JLTV					
	C3I			JALN						
	Munitions/Missiles		JAGM							

Abbrevaition Key:			
AMPV: Armored Multipurpose Vehicle	PIM: Paladin Improvement Program	SSC: Ship-to-Shore Connector	
E-2D: Advanced Hawkeye Aircraft	UCLASS: Unmanned Carrier-Launched Airborne Surveillance and Strike		
HTM: Hard Target Munition	LCS:Littoral Combat Ship	SBIRS: Space-Based Infrared System	
FAB-T: Family of Beyond-line of sight Terminal	WGS: Wideband Global Satellite	GBSD: Ground-Based Strategic Deterrent	
JLTV: Joint Light Tactical Vehicle	JALN:Joint Land Attack Cruise Missile Defense Elevated Netted Sensor System		
JAGM: Joint Air-to-Ground Missile	C3I: Command, Control, Communications and intelligence		

Figure 5. Screening of Candidate Programs by Service and Platform Type

III. Overall Findings

To ground this assessment from the standpoint of requirements setting, an initial discussion was held with the Office of Under Secretary of Defense for Acquisition, Technology and Logistics OUSD(AT&L) Director of Joint Operations Support, attended by representatives from the Joint Staff, Force Structure, Resources, and Assessment Directorate (J-8). This was followed by a more in-depth discussion with the J-8 staff regarding the overall operations of the Joint Requirements Oversight Council (JROC)[19] with regard to schedule setting and monitoring. These meetings indicated that initial MDAP schedules are determined by the sponsoring DOD Component—usually one of the Military Services. J-8 personnel then provided the IDA team points of contact for each Service for further discussions.

Subsequent interviews with points of contact for Service requirements and headquarters acquisition staffs revealed there have been some fairly recent changes in the way that new acquisition programs are established. With recent issues regarding long delays and outright cancellations in several high-visibility programs, there is a strong appreciation in the Service acquisition communities of the need to change. In fact, the Navy and Air Force in particular have made efforts to tighten linkages between the requirements, acquisition, and resource communities early-on in the program development process. In addition, constraints on cost and schedule have been imposed by upper management that limit the trade space in acquisition program development, specifically:

- Better Buying Power 1.0 made affordability caps (a cost constraint) equivalent to a Key Performance parameter (KPP)[20]

- The Navy's Chief of Naval Operations has addressed the importance of schedule, essentially equating it to a KPP[21]

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[19] The JROC has a statutory responsibility to identify, validate, and prioritize joint warfighting requirements. The JROC is chaired by the Vice Chief of the Joint Staff with membership by each of the Military Service vice chiefs. The JROC's role in the acquisition process is to identify and assess capability needs, priorities, and associated performance criteria.

[20] Ashton B. Carter, "Memorandum for Acquisition Professionals Subject: Better Buying Power: Guidance for Obtaining Greater Efficiency and Productivity in Defense Spending" (Washington, DC: United States Department of Defense, September 14, 2010). The first provision is to "Mandate affordability as a requirement."

[21] Chief of Naval Operations, "Mandatory Navy Key Performance Parameters for Cost, Schedule, and Space, Weight, Power, and Cooling Margins," August 1, 2013, The memo actually says, "The goal of this memorandum is to improve the Navy's focus on attributes that will be increasingly important in the current and emerging fiscal and security environment. First, enforcement of cost and schedule requirements is essential. Placing these attributes on par with traditional performance attributes will encourage trades between cost, schedule and performance to deliver programs within likely fiscal constraints while remaining relevant to emerging threats and opportunities." Thus, the memo encourages the kind of tradeoffs necessary to achieve schedules when it is critical to do so (but not when it isn't).

Both of these management edicts seek to put more teeth into program funding and scheduling parameters with the intent to make programs adhere more closely to their stated cost and time estimates. There is, however, a danger that this greater emphasis on developing and employing realistic program costs and schedules will discourage the development and use of advanced technologies needed to meet more stressing performance requirements, when that objective might be more important than achieving a predetermined (and possibly somewhat arbitrary) schedule or cost objectives that were perhaps unrealistically set. That, of course, is a complicated and open-ended issue about which much has been written.

The intent of the Service up-front efforts to better link their requirements, acquisition and resource organizations is to achieve realism across these three domains. However, given that intent, there is little evidence from the interviews conducted and programs examined that trades were considered that lowered requirements in favor of accelerating schedules. It is important to note that these initiatives to discipline the program development process are fairly recent, and the fruits of these initiatives may not be evident for some time. Currently, under highly constrained resources and attendant higher-level concerns from both Service and Office of Secretary Defense (OSD) executives, there is strong motivation for such "realism."

United States Code (Title 10 USC 2366a) requires that program managers provide notification if their program is likely to exceed its prescribed schedule by more than 25%. Specifically, pursuant to 10 USC 181 (which specifies the duties of the JROC) once the Milestone Decision Authority (MDA) certifies various criteria at Milestone A, the program manager must notify the MDA if, at any time prior to Milestone B, it is determined that there will be insufficient time to deliver an IOC and that the program is likely to exceed the schedule objective by more than 25 percent.

This raises the basic question: How could we tell if a program will exceed the IOC objective established by the JROC? It turns out that tracking the status of programs is fraught with ambiguity. First, routine program reporting requirements prior to Milestone B are scant, and may be inadequate for tracking status relative to these notification parameters.[22] Secondly, an analysis conducted by OUSD(AT&L) determined that roughly two-thirds of the time, an IOC target was never established in the ICDs for the programs reviewed. (That is consistent with the findings of this study for the small sample of programs investigated.) Generally, schedule dates are not set firmly until approval of the Capabilities Development Document (CDD) which, according to CJSC Manual 3170,[23] must

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[22] If reporting is required by pre-Milestone B contracts, the Earned Value Management Reports should provide some early warning on schedule delays.

[23] Joint Staff, "Manual for the Operation of the Joint Capabilities Integration and Development System," February. 12, 2015.

"Specify the target date for IOC and FOC attainment..." (The ICD is also required to address IOC, but with less specificity.) So at the time of the Analysis of Alternatives (AoAs) and Milestone A starting technology maturation, for the large majority of programs a requirements-driven schedule is not specified. See Appendix B for a summary of extracts from Chairman, Joint Chiefs of Staff, and DOD issuances regarding setting schedules and making tradeoffs involving schedules.

A. Questions for Program Offices

To focus on specific concerns regarding setting of schedules for individual MDAPs, the IDA study team provided a detailed set of questions to each of the program offices and responsible offices[24] for the selected programs. These questions guided discussions and several programs in fact provided written responses. The questions submitted are listed below:

Setting Acquisition Program Schedule Dates:

1. At what time were acquisition schedule dates for your program *first* specified? What were the key dates?

2. In what official document were the dates specified and under what approval authority was it promulgated?

3. What requirements documents supported specification of those dates?

4. What role did the requirements community play in establishing the schedule dates for the acquisition program?

5. To what extent were tradeoffs between schedule and performance and/or costs made in establishing those dates and how were they done? What tools were used in analysis supporting such tradeoffs?

6. How do you determine the feasibility of development schedules? What role do contractors play in making such estimates? How are schedule parameters reflected in Requests for Proposals, proposals, and contracts?

Revising Acquisition Program Schedule Dates:

1. Provide a chronology of any changes to key schedule dates since originally approved and briefly discuss the reasons for the changes.

2. What role has the requirements community played in revisions to schedule dates?

3. To what extent were tradeoffs between schedule and performance and/or costs made in the change process?

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[24] E.g., Staff action officers for programs.

Funding-related Issues:

1. Has the program always been fully funded by the Component?

2. What were the impacts of resource management decisions, funds-execution-related cuts, Congressional cuts, Continuing Resolutions, etc.?

B. Findings from Review of Selected MDAPs

1.   Overall Insights

Insights emerged from the programs investigated.

- Most of the programs examined are in response to requirements first stated in the 2004–2010 timeframe. Most IOCs are in the 2020+ timeframe

- Most program requirements are near-term and threat-driven, though obsolescence also has been a factor.

- Several programs appear to have a requirements–capabilities mismatch; the problems appear related to unavailability of technology needed to achieve the necessary performance relative to the defined threat. Capabilities will be available *10 years or more after the threat emerged.*

These observations raise questions concerning how threats are defined and when they will emerge operationally.

2.   AMDR and NGJ

Figure 6 displays insights for the AMDR and NJG programs. For the aspects under consideration in this task, these two Navy programs are structurally very similar, thus their findings have been combined. Both were driven by the need to employ Gallium Nitride (GaN) chip technology to achieve the required performance within space, weight, and power (SWAP) constraints.

NGJ and AMDR

- Requirements are strongly "near-term" threat-driven
  - New capabilities of potential adversaries:
    - Surface-to-air missiles—longer range, more sophisticated
    - Radars—range, frequency bands, counter-antiradiation missile capabilities
    - Tactical ballistic missiles and supersonic cruise missiles
- Requirements validated in studies in the 2006-2010 timeframe
- Both systems need greater power and sensitivity and have space, weight, and power constraints
- The technological solution is Gallium Nitride (GaN) integrated electronics (e.g., transmit/receive modules)
  - GaN, at the time program formulated, was an emerging technology in DoD research and development activities
  - Issue of technical risk versus alternatives that could meet needs were matters of judgment
  - DoD programs to accelerate GaN paralleled programs that would employ it

These programs illustrate the need to address technology maturity in program development and planning
- Must be addressed prior to Milestone A
- Are appropriate processes in place (early systems engineering linked to requirements process)?
- How were / are technology maturation processes considered in setting schedules and attendant risks? How should they be?

Figure 6. Findings for AMDR and NGJ

The AMDR program replaces two radars in the Aegis system on future production of DDG-51 destroyers. The new radars will be installed on the Flight III DDG-51s beginning with the FY2016 procurement. The "in-yard need date" was originally established as 4th quarter FY2019 but in 2013 was slipped to 1st quarter FY2020. That requirement is the primary schedule driver for the program, since any slip in deliveries would result in what could be an expensive slip in ship production schedule. The program has three major components—an S-band radar, an X-band radar, and a radar control system and interface with Aegis. Importantly, the S-band radar, which is crucial to the meeting the program requirements, drew upon what was at the time an emerging technology—GaN integrated circuits. These are needed because of the high sensitivity and power required to detect incoming threats at sufficient range for effective intercept. A single S-band radar employs several thousand GaN transmit-receive modules. When the program began, GaN technology was not yet available and had to be matured to meet this need. Combined efforts of the DOD through Defense Advanced

Research Projects Agency and Military Service technology development programs with selected electronics contractors succeeded in maturing GaN for this use.

The NGJ program replaces some of the capabilities of the AN/ALQ-99 jammers used on the EA-18G "Growler" electronic warfare aircraft. Program officials stated that it would have been desirable to have the NGJ capabilities when the EA-18Gs were first fielded in late 2009. However, the NGJ is now scheduled for first delivery in ~2020. While a lack of sufficiently high priority on the part of the Navy was cited initially as the reason for delay by Navy personnel, further discussion and investigation indicates that the availability of GaN integrated circuits was also a significant driver. The GaN technology enables achieving the required power within the SWAP constraints of the host aircraft. It is not clear that this technology could have been available to meet the 2009 objective. Use of older Gallium Arsenide technology might have been acceptable, but would not have provided as robust a capability.

Both of these programs appear to have followed processes that qualify as "best practices."

3. 3DELRR

Figure 7 displays insights for the 3DELRR program. This program has a long and complicated history. The initial development was begun by the U.S. Marine Corps in the 2003 timeframe. The Marine Corps perceived a need to replace their AN/TPQ-59 airspace control radars. The Marine Corps program, known at the time as the Highly Expeditionary Long Range Air Surveillance Radar, had a projected IOC in 2012. The Air Force participated in the program in a limited way with a plan to buy the radars when available for procurement.

In its 2008 Program Objective Memorandum, the Marine Corps decided not to replace the AN/TPQ-59 radars and proposed to terminate the program. The Air Force still had a requirement to replace the AN/TPQ-75 radars, which were fielded in the early 1970s and were deemed obsolete. Therefore, the Air Force took over the lead, while the Marine Corps continued participation with a modified objective of a product improvement of the AN/TPQ-59. The Air Force acquisition executive in December 2007 signed a memorandum to establish its own program. In February 2009, the Defense Acquisition executive designated the program as a "special interest" MDAP and directed a joint Air Force/Marine Corps program. However, in August 2009, despite pressure from OSD, and in light of "fiscal realities," the Marine Corps withdrew all financial participation in the program, stating its intent to procure the Air Force-developed 3DELRR in the 2025 timeframe. A resource management decision in January 2011 provided $24.1 million in FY2013 to compensate the Air Force for the Marine Corps withdrawal (but no funding in the out-years). The upshot of this convoluted process is

that 3DELRR was delayed by six years with the original IOC of 2014, set in 2006, now being 2020.[25] The operational impact has not been assessed.
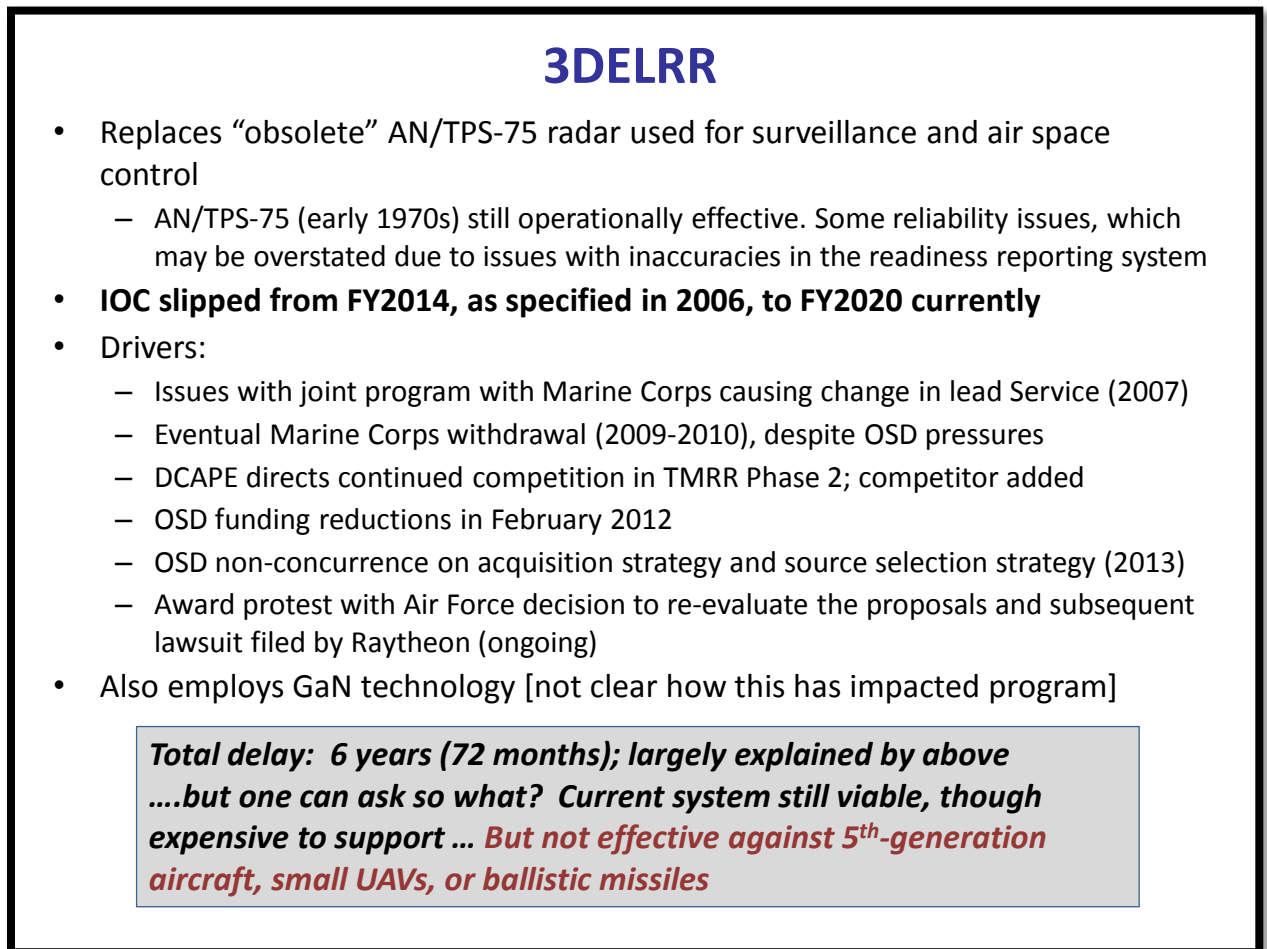
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3DELRR

- Replaces "obsolete" AN/TPS-75 radar used for surveillance and air space control
  - AN/TPS-75 (early 1970s) still operationally effective. Some reliability issues, which may be overstated due to issues with inaccuracies in the readiness reporting system
- **IOC slipped from FY2014, as specified in 2006, to FY2020 currently**
- Drivers:
  - Issues with joint program with Marine Corps causing change in lead Service (2007)
  - Eventual Marine Corps withdrawal (2009-2010), despite OSD pressures
  - DCAPE directs continued competition in TMRR Phase 2; competitor added
  - OSD funding reductions in February 2012
  - OSD non-concurrence on acquisition strategy and source selection strategy (2013)
  - Award protest with Air Force decision to re-evaluate the proposals and subsequent lawsuit filed by Raytheon (ongoing)
- Also employs GaN technology [not clear how this has impacted program]

> *Total delay: 6 years (72 months); largely explained by above ….but one can ask so what? Current system still viable, though expensive to support … But not effective against 5th-generation aircraft, small UAVs, or ballistic missiles*

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Figure 7. Findings for the 3DELRR Program

4. Counter-IR Countermeasure (CIRCM) System

Figure 8 displays insights for the CIRCM program. This program is developing a lightweight laser countermeasure system for smaller helicopters. The device will use a laser beam to confuse infrared (IR)-guided missile seekers. The existing protection for such helicopters is the Common Missile Warning System (CMWS), combined with the AN/ALQ-144 flare dispenser. As adversary

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[25] As of this writing, the program is being delayed further by a lawsuit emanating from a protest of the award of the EMD contract, with requested funding in the FY2016 President's budget greatly reduced. Thus, a 2020 IOC is probably no longer achievable.

IR-guided missile seekers become more advanced, they are able, using various techniques, to ignore the flares and continue to target the aircraft.

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CIRCM

- Army program with Navy participation to develop a lightweight IR missile countermeasure system--improved, lighter-weight version of the ATIRCM* system
- Laser-based system to defeat in-flight missiles; works with the *Common Missile Warning System,* which detects IR missile threats
- *Existing AN/ALQ-144 series systems (1980s) not capable against modern man-portable IR missiles—operational losses prompted increase in priority*
- Materiel Development Decision in 2009
    - **Army planned to go directly to Milestone B [accelerated acquisition]**
    - **However, using a Broad Agency Announcement, Army solicited off-the shelf solutions and received equipment from five vendors; testing showed *none* was ready for EMD**
    - OSD concluded threat dictated a need date of FY2017 and directed trade-off analyses to meet it; *Army Program Manager asserted that meeting that date not possible*
    - Army directed to prepare for an Milestone A
- Milestone A in 2011 approved a competitive TMRR phase
- In July 2014, an Acquisition Decision Memorandum approved release of EMD Request for Proposals

    Advanced Threat Infrared Countermeasures used on CH-47s

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Figure 8. Findings for the CIRCM Program

The Army began development of a system known as ATIRCM (Advanced Threat IR Countermeasure) in 1995. That program has a long, turgid history.[26] Originally intended to protect all Army helicopters, in 2003 it was scaled back to only procuring systems for the CH-47 fleet because of excessive weight (325 lbs.) with procurement of 83 systems completed in 2009. The CIRCM has a weight-limit threshold KPP of 120 lbs. with an objective of 65 lbs. and will equip the Army's AH-64, UH-60, OH-58, and Marine Corps AH-1Z fleets. It is also planned to replace the existing ATIRCMs on CH4-47s. The CMWS, which was developed in conjunction with (and also works with) the ATIRCM, detects threat missile launches and provides pointing information to the laser projector.

In 2009, the CIRCM was initially conceived as a fast-track acquisition—going directly into Milestone B using what were to be off-the-shelf solutions. However, when the Army tested the technologies offered by potential vendors in response to a Broad Agency Announcement, it

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[26] See Davis, Gregory, et al, *Root Cause Analysis for the ATIRCM/CMWS Program*, IDA Paper P-4601, Alexandria, VA: Institute for Defense Analyses, June 2010.

determined that none was ready for moving into EMD. Therefore, the Army revamped the program as a traditional acquisition with a Milestone A in 2011, approving initiation of TMRR. A Milestone B in July 2014 approved release of the RFP for EMD. Thus, the Army determined that instead of moving quickly into EMD in 2009, the lack of sufficiently capable technology delayed EMD for five years.

It is important to note that this is clearly a threat-driven program where existing helicopters are vulnerable and have been lost to enemy IR missiles in Iraq and Afghanistan. This drove the urgency to achieve rapid acquisition—but technology providing needed performance within the required weight limit had not been developed. Under these circumstances the restructuring of the program was obviously necessary, but the question to be asked is whether an earlier technology maturation program, begun for example in 2003 when the weight issue with ATIRCM emerged, would have provided the needed technology earlier.

This program shows that the objective of more rapid acquisition, even when there are clear operational consequences of not doing so, must be done with clear understanding of the state of the underlying technologies. If acquisition is to be accelerated, then careful attention must be paid investments in technology maturation.

5. Integrated Force Protection Capability (IFPC) Increment 2-I Block 1

Figure 9 displays insights for the IFPC program. This system currently has an objective of providing fixed-point and "semi-fixed-point" force protection, initially against cruise missiles (CMs) and Unmanned Air Vehicles (UAVs). A later increment (Block 2) is planned for the same launchers to provide protection against rockets, artillery and mortars (RAM). (Block 3, which would provide area defense, is not contemplated to start until post-2025.) Initially the program was focused on providing a more robust capability to RAM as an existing threat—more robust than the C-RAM system[27] that was deployed to Iraq to protect forward operating bases. However, it was determined that available technology would not meet that requirement. Therefore, in September 2012 the Army Vice Chief of Staff refocused the program on protection against CMs and UAVs. Indeed the Block 2 aimed at RAM is not scheduled to start until 2019. (A lower-level technology program is continuing, and the Army hopes to have a Milestone A for Block 2 in FY2019.)

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[27] Counter-RAM system, based on the Navy Phalanx radar-directed gun system for close-in protection of ships.

IFPC-Increment 2-Intercept (Inc. 2-I)

- Began as a requirement to counter rockets, artillery and mortars (RAM)
  - Various ICDs, Operational Requirements Documents, and CDDs in 2002-2010 — *This is an existing threat*
  - No technical solutions appeared to meet requirements
- In January 2011 OSD directed Army to address capability gap for point defense against UAVs and cruise missiles (driven by Major Contingency Operations threats)
- MDD: Aug. 2011
- AoA completed April, 2013
- Army defined the program as follows:
  - Inc. 2-I Block I—counter UAVs and cruise missiles (IOC 4QFY19)
  - **Incr. 2-I Block 2 (*beginning* FY19) is to counter RAMs**
  - Incr. 2-I Block 3 **(FY27)** is to provide area defense against UAVs and cruise missles
- At Milestone A, Army proposed an in-house development of "Multi-Mission Launcher" prototypes:
  - Approach is to "leverage existing sensors and mission command...[and] an existing interceptor as a design reference and point of departure." (Acquisition Strategy, 06/2014)
  - MS-A approval - March 2014

> Appears that the incremental acquisition strategy won't provide response to key existing threats for very long time. How will that impact operations?

Figure 9. Findings for the Integrated Fire Protection Capability Program

IFPC raises interesting questions concerning scheduling: apparently the original and existing threat driving the program turned out to be too difficult to meet so that the program was redirected to what appears to be a more easily attainable technical objective—but not the originally defined threat. The decision also appears to have been in response to the 2012 policy shift away from irregular warfare and stability operations toward major contingency operations.

6. F-22 3.2B Modernization

Figure 10 displays insights for the F-22 3.2 Modernization Program. This program, one of a series of modifications to modernize the Air Force F-22 Raptor fighter/bomber aircraft fleet, was designated a "special interest" MDAP by the USD(AT&L) in December 2011. The program's RDT&E funding exceeds the MDAP threshold ($500 million) but the procurement funding does not. Many acquisition programs exceed the thresholds specified by statute, but the DOD Components have some discretion in deciding whether to designate a program as an MDAP. However, the Defense Acquisition Executive has the authority to designate a program as an MDAP, and that was the case here. The reasons for that decision have not been documented.

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F-22 3.2B Modernization

- Part of a long-term program to maintain and upgrade F-22 capabilities—only increment designated an MDAP*
- Requirement based on a 2007 Capability Production Document for all increment 3 modifications
  - MDD in 2011
  - Acquisition Decision Memorandum designated MDAP *[rationale not known]*
  - No Milestone A
  - Milestone B June 2013
- Includes:
  - Modifications to employ AIM-120D and AIM-9X block 2 missiles
    - AIM-9X block 2 IOCs this year; rate production for AIM-120D this year (no IOC specified)
  - New geolocation capability (locates emitters)
  - Improved electronic protection
  - Procurement of mod kits begins in FY16
  - "Required Assets Available (RAA)" Sepember 2019 (means first unit equipped)

*RDT&E exceeds threshold

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Figure 10. Findings for the F-22 3.2B Modernization Program

The primary drivers of schedule appear to be the modifications to enable the aircraft to carry the AIM-120D AMRAAM and AIM-9X Sidewinder Block II missiles. These missiles will be available for employment this year, but the aircraft modifications will not be started until 2019, so the nation's pre-eminent fighter aircraft will not be capable of employing the most advanced air-to-air missiles for four years or more. Other mods include the ability to passively locate emitters via coordinated signal intercept by two or more F-22s. This technology is the most advanced being implemented in this modernization program. The other area of improvement is in the electronic protection suite.

C. Summary and Conclusions

Most of the programs examined are in response to requirements first stated in the 2004–2010 timeframe and most have Initial Operational Capability (IOC) dates in the 2020-plus timeframe. Most requirements are near-term threat-driven, though obsolescence is also a factor. It is our observation that the needed capabilities will be available some *10 years or more after threat emerged. That is, the threats these programs would address either exist now or will emerge into operational reality before the systems are fielded.* That raises questions of how threats are defined and when they are seen as realized. From that we conclude that *for some programs there appears to be a requirements–capabilities mismatch; where the problem appears to be the unavailability of technology needed relative to the defined threat.*

The study arrived at the following more specific findings:

- Requirements inputs on IOC/schedules are difficult to pin down—documentation is lacking or difficult to obtain. The IOCs reflected in acquisition documents were drawn from requirements documents drafted between Milestones A and B[28]—relatively late in process– and it is not clear whether specified IOCs were based on need or what is achievable. JCIDS requirements documents are archived in the Knowledge Management and Decision System maintained on the SIPRNET by the Joint Staff (J-8). That system is difficult to use and does not appear to contain all relevant documents.

- The team was not successful in obtaining several Capabilities Based Assessments (CBAs) and ICDs that were specific for systems reviewed. Only one system (AMDR) had a clear statement (in the AoA) of when specific threat capabilities were projected to be operational.

- Program schedule setting varies in rigor.

  - The Navy appears to have a well-defined process (run by N8[29]) to initiate programs based on agreed understanding between "requirers," developers, and resource planners.

  - The Air Force has a similar process but with a lesser role for resource planners.

  - For programs examined, there was little evidence of consideration of tradeoffs of performance requirements and/or costs in favor of accelerated schedules.

- Focus on technology maturation as part of early acquisition strategy can be crucial.

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[28] Up to the interim version of DODI 5000.02 published in November 2013—i.e., the one in effect when all the programs investigated were initiated. The current 5000.02 requires a draft Capabilities Development Document *prior to* Milestone A.

[29] Office of Deputy Chief of Naval Operations, Resources, Requirements and Assessments

– The AMDR and NGJ programs showed that technology-driven programs can be successful when attention is focused on earlier technology maturation. CIRCM is an example of the apparent failure to do that.

- Tradeoffs of performance, cost, and schedule. If it is deemed essential to meet firm schedule dates to support operational or other critical needs, it may be necessary to make tradeoffs of performance (especially in regard to the technologies employed) and/or costs in order to achieve the schedule needed. Although the current DODI 5000.02 contains several provisions requiring tradeoff analyses among cost, schedule, and performance, there is no explicit provision to consider the relative urgency of operational needs in making such tradeoffs. An explicit statement along those lines would be preferred. Changes also may be needed to Joint Staff procedures in order to identify such critical need dates.

  – Appendix B documents the provisions found in the current DODI 5000.02 that address tradeoffs. The main areas most relevant hereto are in 1) systems engineering and 2) performing AoAs. Under the "Development Planning" heading of Systems Engineering, the DODI 5000.02 contains the following language:

  > During the acquisition life cycle, the Program Manager will conduct systems engineering trade-off analyses to assess system affordability and technical feasibility to support requirements, investment, and acquisition decisions. Systems engineering trade-off analyses will depict the relationships between system life-cycle cost and the system's performance requirements, design parameters, and delivery schedules. The analysis results should be reassessed over the life cycle as system requirements, design, manufacturing, test, and logistics activities evolve and mature. (Enclosure 3, Paragraph 4a, p. 82)

  The second sentence of this provision is the gist; however, it would be desirable to add language that the analysis should consider performance and schedule trades to best meet user needs for both capabilities and timeliness, in light of the readiness of the critical technologies.[30]

  In interviews relating to the programs that were examined in depth, evidence of such tradeoff studies was not identified despite specific requests.[31]

- Funding impacts: It is difficult to discern causes from effects for funding reduction impacts on schedules.

  – The only clear case identified in which funding issues caused program delay was NGJ, which incurred a double-hit for execution delays caused by award protest.

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[30] As noted in Appendix B, these directive provisions pre-date the current DODI 5000.02 in the form of a "Directive Type Memorandum" dated September 2010. In addition, "corporate memory" was found to be incomplete—it is quite possible that such trades were made in the early stages of programs but these records are not readily available.

[31] Though not identified by Air Force personnel, a reference to such tradeoff analysis was discovered for the 3DELRR program in the Technology Development Strategy May 2009 (page 9). Air Force headquarters was unable to provide any additional information.

- Several programs appeared to lack priority in the program/budgeting process—3DELRR, NGJ, CIRCM, IFPC. In the case of NGJ and CIRCM, that seems inconsistent with the need to counter near-term, or even current, threats.

- Process delays, such as protests, acquisition strategy reformulation, and contract rework have impacts, measured more in months than in years—but they do not appear to be "long poles in tent" relative to other factors.

  - A possible exception is 3DELRR. This program is currently the subject of a lawsuit regarding the resolution of protests of the EMD contract award. The program will remain on hold until the suit it resolved—an indeterminate period of time.

Broader Insights on the Importance of Cycle Time

Our research has led to some broader thoughts that fall under the rubric of "cycle time."

While much has been said and written on defense acquisition cycle time, often these thoughts do not include the obvious question: Why is there concern over acquisition cycle time? In our view, reducing cycle time *per se* should not be the prime objective, since that may lead to a number of undesired outcomes, such as greatly increased costs and/or inadequate performance. At times it may be impossible to achieve stated performance requirements faster given technological limitations. Trading off the "required" performance to get something out quickly has attendant downsides—notably the inability to meet what users say they need. Rather, the cycle-time goal should be to structure and execute acquisition programs to meet the needs of operational forces, in terms of both capabilities and timeliness. Though simply stated, achieving that end has many dimensions. It may not be possible to provide the capabilities desired by the user within the desired time constraint—in fact, in today's world of rapid technological dispersion, that situation might be the norm. So tradeoffs must be made to provide the best capabilities achievable by the time needed within an acceptable level of risk.

Thus, the real "cycle time" issue is how to provide the operational forces weapon systems that have *the needed capabilities* and *that are fielded when needed*. To ensure that those dual objectives are met, requirements and acquisition communities must work together closely in the initial stages of systems acquisition to define programs based on technologies that can be matured and implemented in the required timeframe within an acceptable level of risk. If that process is not effectively accomplished, the ensuing program faces a high risk of failure to achieve its *fundamental objective* of providing the user the right capabilities at the right time.

There is no "one size fits all" approach to achieving the fundamental objective. At one extreme, there are rare situations where it is necessary to seek highly ambitious capabilities, to accept higher risks, to confront unknowns. Schedule and cost estimates will be more uncertain. It is the role

of leadership to determine whether the requirements for such capabilities and their operational value justify taking on higher risks. The risks must be identified and articulated carefully to leadership so that an informed decision can be reached.[32]

At the other extreme are the "rapid acquisition" programs that meet immediate needs and therefore should be acquired using a low-risk, predictable approach with well-defined, currently available technologies. Those programs are usually not MDAPs, though there have been exceptions (notably the Stryker and MRAP programs).

Most MDAPs fall between these extremes, and for most of them getting it right is more important than getting it soon. Undue emphasis on cycle time and predictability of schedule can inhibit pursuit of programs that are aimed at difficult objectives that may take more time to achieve. However, that does not mean being complacent in requiring that programs that aim high; be well-founded on clear assessment of underlying assumptions regarding technical risk; and have a well-formulated program strategy to address that risk. If a program is reaching for performance that stresses the state of art, then:

- The rationale in terms of future threat or compelling operational need should be clearly identified;

- Risks should be explicitly defined, independently verified, and made clear to all management levels;

    - There should be well-defined approaches pursued to reduce the risk by carefully maturing the technologies and addressing their integration into the system as the system evolves over time,

    - Independent assessments of risks should be the job of the systems engineering establishments (OSD and Services);

- The means for accommodating technology improvement and change into the system as it develops and is fielded overtime should be a clear part of the acquisition strategy; and

- The program should receive high-level oversight throughout.[33]

Frequently, the acquisition system must deal with problems created by inadequately thought-through program initiation, attempting to achieve high-impact defense capabilities on an unexecutable schedule. Clearly this is a problem that DOD needs to address more broadly and strategically.

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[32] A good depiction of approaches to address technology level and time to field is shown in *Army Strong: Equipped, Trained and Ready*: Final Report of the 2010 Army Acquisition Review, January 2011, Figure 41, p. 100.

[33] The F117 stealth aircraft is a well-known example of this approach. See Richard Van Atta, et al., *Transformation and Transition: DARPA's Role in Fostering an Emerging Revolution in Military Affairs*, Volume 1, IDA Paper P-3698, Alexandria, VA: Institute for Defense Analyses, April 2003, pp. 11–15.

Addressing it requires rigorous assessments of the state of technologies, informed by technology prototyping, experimentation, and demonstration of advanced concepts, to assess the prospects and potential value to the user. The maturation of underlying enabling technologies needs to be given adequate and sufficiently early focus and funding. Without such preliminary steps, the risk will fall onto the MDAPs, which then proceed with too little information and too little certainty and thus run risks of unachievable schedules, cost growth, or even program cancellation.

Appendix A
Requirements Documents Identified/Reviewed

Requirements Documentation

Program	CBA	ICD	CDD/CPD	AoA
NGJ **IOC: 3QFY21**	EW CBA 2009[a]	EW ICD 2009[a]	Feb.'15 draft	July 2011
AMDR **IOC: 4QFY23**	Integrated Air & Msl. Def. '09.	MAMDJF[b] ICD 2006 Radar/Hull Study 2009	Apr. 2013	MAMDJF Aug. 2007
CIRCM **IOC: 4QFY20**	JCB "Mini-CBA" [a] AS FSA 2008	Aircraft Survivability (AS) 2011[a]	Oct. 2013	Waived by DAE per Army request
IFPC **FUE: 4QFY19** **IOC: 3QFY20?**	None identified	Int. Unit, Base Install. Protection 2009	Air & Msl Def Sys of Sys 2010[a]	Apr. 2013 (revised) [a]
3DELRR **IOC: 2QFY20**	None identified	June 2012[a]	July 2013 CPD 2006 CDD by USMC	Apr. 2014[a]
F-22 3.2B Mod **RAA: 4QFY19**	None identified	None identified	Enhanced Global Strike 2007[a] Incr. 3.2B KSAs Sep.2012[a]	Apr. 2011[a]

[a] *Not obtained*
[b] *Maritime Air & Missile Defense of the Joint Force*
[c] *The Functional Solutions Analysis and Functional Needs Analysis (CBA components) are appendices to the ICD*

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Figure 11. Requirements Documentation for MDAPs Investigated

Appendix B
Provisions Regarding Establishment of Schedules in DOD and Joint Staff Issuances

The study team reviewed both Joint Capabilities Integration and Development System (JCIDS) documentation and Department of Defense Instruction (DODI) 5000.02 for specifications regarding schedules and schedule setting.

JICDS documentation

Reviewed CJCSI[34] 3170.01I (Jan. 20150) Joint Capabilities Integration and Development System (JCIDS) and Joint Staff *Manual for the Operation of the Joint Capabilities Integration and Development System (JCIDS)*

CJCSI 3170.01I contains *no explicit references at all to Initial Operational Capability (IOC) or schedule setting*. It does have one very general provisions regarding performance, cost, and schedule tradeoffs, but nothing addressing schedule tradeoffs per se—e.g., whether it's better to have lesser capabilities sooner or greater capabilities later.

The associated manual, on the other hand, contains numerous references; which are summarized below:

- Capabilities Based Assessments (CBAs) are to "consider the timeframe under consideration, applicable threats, ...joint [operational] concepts, and related effects to be achieved." The timeframe is "important both to help establish the conditions and threats under which the mission is to be carried out, and as a key component in discussions between the requirement Sponsor and the acquisition community in determining the required IOC and FOC dates."
- Initial Capabilities Documents (ICDs) are to "Identify the timeframe under consideration for IOC and Full Operational Capability (FOC) based on input from supported/supporting Combatant Commands and the acquisition community."
- Capabilities Development Documents (CDDs) are to "Define what actions, when complete, will constitute attainment of IOC and FOC of the current increment. Specify the target date for IOC and FOC attainment based on discussions and coordination between the requirement Sponsor and the acquisition community. Describe the types and

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[34] Chairman, Joint Chiefs of Staff Instruction.

quantities of assets required to attain IOC and FOC." (An identical provision is included for Capabilities Production Documents (CPDs).)

It also has provisions regarding tradeoffs among performance, cost, and schedule.

DODI 5000.02, Operation of the Defense Acquisition System (Jan. 2015).

DODI 5000.02 also has no explicit provision regarding the "less capable sooner vs. more capable later" question.

It does, however, have several provisions regarding tradeoffs between performance, cost, and schedule.

The first is within the systems engineering context and what is called "Development Planning":[35]

> In preparation for the Materiel Development Decision, and to inform an Analysis of Alternatives (AoA), the DOD Components will conduct early systems engineering analyses and conduct an assessment of how the proposed candidate materiel solution approaches are technically feasible and have the potential to effectively address capability gaps, desired operational attributes, and associated external dependencies.

> During the acquisition life cycle, the Program Manager will conduct systems engineering trade-off analyses to assess system affordability and technical feasibility to support requirements, investment, and acquisition decisions. Systems engineering trade-off analyses will depict the relationships between system life-cycle cost and the system's performance requirements, design parameters, and delivery schedules.

> In support of the validation of the Capability Development Document (or equivalent requirements document), the Program Manager will conduct a systems engineering trade-off analysis showing how cost varies as a function of system requirements (including Key Performance Parameters), major design parameters, and schedule. The results will be provided to the MDA and will identify major affordability drivers and show how the program meets affordability constraints

How these results are "provided to the MDA" is not known. Neither the Service staffs nor the program offices contacted informed the study team of any such tradeoffs despite being specifically asked.

The next discussion of tradeoffs is under the Analysis of Alternatives (AoA)[36] procedures:

2. AOA PROCEDURES

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[35] DODI 5000.02, JANUARY 2015, Encl.3, para. 2, (page 82).

[36] DODI 5000.02 January 2015, Encl. 9, para. 2, (page 125).

a. The Director of Cost Assessment and Program Evaluation (DCAPE) develops and approves study guidance for the AoA for potential and designated Acquisition Category I and IA programs and for each joint military or business requirement for which the Chairman of the Joint Requirements Oversight Council (JROC) or the Investment Review Board is the validation authority. In developing the guidance, the DCAPE solicits the advice of other DOD officials and ensures that the guidance requires, at a minimum:

(1) Full consideration of possible tradeoffs among life-cycle cost, schedule, and performance objectives (including mandatory key performance parameters) for each alternative considered.

(2) An assessment of whether the joint military requirement can be met in a manner consistent with the cost and schedule objectives recommended by the JROC or other requirements validation authority.

(3) Consideration of affordability analysis results and affordability goals if established by the Milestone Decision Authority (MDA).

Once the AoA is completed, DCAPE performs an assessment and reports the results in a memorandum to the MDA:[37]

In the memorandum, the DCAPE assesses:

(1) The extent to which the AoA:

(a) Examines sufficient feasible alternatives

(b) Considers tradeoffs among cost, schedule, sustainment, and required capabilities for each alternative considered

(c) Achieves the affordability goals established at the MDD and with what risks

(d) Uses sound methodology

The last area in which tradeoffs are mentioned in DODI 5000.02 is in the Developmental Test and Evaluation (DT&E) context:[38]

DT&E ACTIVITIES

a. DT&E activities will start when requirements are being developed to ensure that key technical requirements are measurable, testable, and achievable.

b. A robust DT&E program includes a number of key activities to provide the data and assessments for decision making. The DT&E program will:

(1) Verify achievement of critical technical parameters and the ability to achieve key performance parameters, and assess progress toward achievement of critical operational issues

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[37] DODI 5000.02 January 2015, Encl. 9, para. 2(c), (page 126).

[38] DODI 5000.02 January 2015, Encl. 4, para. 4, (page 91).

(2) Assess the system's ability to achieve the thresholds prescribed in the capabilities documents

(3) Provide data to the Program Manager to enable root cause determination and to identify corrective actions

(4) Validate system functionality

(5) Provide information for cost, performance, and schedule tradeoffs

(6) Assess system specification compliance

Note that in all these instances, while schedule is mentioned as a tradeoff parameter, it receives no particular emphasis (unlike affordability). There is no provision directing explicit consideration of whether capabilities can be provided in time to meet operational needs nor the tradeoffs between employing less advanced (and less risky) technologies to achieve a high confidence of meeting a need versus more advanced technologies providing greater capabilities later (but probably with higher risks).

Virtually all of these provisions are new for this issuance of 5000.02, which first appeared in "interim" form in November 2013. Since all the programs investigated in depth in this task had MDDs or other initial milestone decisions prior to that date, they were all formulated based on the 2008 version of DODI 5000.02. Thus they arguably cannot be held accountable for not doing the tradeoff analyses called for in the above excerpts. However, Directive-Type Memorandum 10-017, "Development Planning to Inform Materiel Development Decision (MDD) Reviews and Support Analyses of Alternatives (AoA)," covering the development planning provisions was issued originally in September 2010.

The earlier editions of CJCS 3170 and the accompanying manual were not significantly different from the current version with regard to scheduling issues.

Appendix C
Illustrations

Appendix D Abbreviations

3DELRR	3-Dimensional Expeditionary Long-Range Radar
ATIRCM	Advanced Threat Infrared Countermeasure
AMDR	Air and Missile Defense Radar
AoA	Analysis of Alternatives
CBA	Capabilities Based Assessment
CMWS	Common Missile Warning System
CDD	Capabilities Development Document
CIRCM	Common Infrared Countermeasures
CM	Cruise Missile
CPD	Capabilities Production Document
DCAPE	Director, Cost Analysis and Program Evaluation
DOD	Department of Defense
DODI	Department of Defense Instruction
EMD	Engineering and Manufacturing Development
FOC	Full Operational Capability
FY	Fiscal Year
GaN	Gallium Nitride
ICD	Initial Capabilities Document
IFPC	Integrated Force Protection Capability
IDA	Institute for Defense Analyses
IOC	Initial Operational Capability
IOT&E	Initial Operational Testing and Evaluation
IR	Infrared
JCIDS	Joint Capabilities Integration and Development System
JROC	Joint Requirements Oversight Council
KPP	Key Performance Parameter
MDA	Milestone Decision Authority
MDAP	Major Defense Acquisition Program
MDD	Materiel Development Decision
MRAP	Mine-Resistant Ambush Protected

NGJ	Next Generation Jammer
OUSD(AT&L)	Office of Under Secretary of Defense, Acquisition
OSD	Office of Secretary of Defense
RAM	Rockets, Artillery and Mortar
RDT&E	Research Development Test and Evaluation
SARs	Selected Acquisition Reports
SWAP	Space, Weight, and Power
TMRR	Technology Maturation and Risk Reduction
UAV	Unmanned Aerial Vehicle
USD	Under Secretary of Defense
USC	United States Code

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE (DD-MM-YY)	2. REPORT TYPE	3. DATES COVERED (From – To)
XX-06-2015	Final	

4. TITLE AND SUBTITLE

Assessing Weapon System Acquisition Cycle Times: Setting Program Schedules

5a. CONTRACT NO.

HQ0034-14-D-0001

5b. GRANT NO.

5c. PROGRAM ELEMENT NO(S).

6. AUTHOR(S)

Richard H. Van Atta, Project Leader
R. Royce Kneece, Jr.
Christina M. Patterson
Anthony C. Hermes
Rachel D. Dubin

5d. PROJECT NO.

5e. TASK NO.

AB-6-3685

5f. WORK UNIT NO.

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
Institute for Defense Analyses
4850 Mark Center Drive
Alexandria, VA 22311-1882

8. PERFORMING ORGANIZATION REPORT NO.
IDA Document D-5530
IDA Log H 15- 000608

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)

Office of the Under Secretary of Defense (AT&L)
Office of Performance Assessments and Root-Cause Analyses
3620 Defense Pentagon, Room 5E609
Washington, DC 20301-3620

10. SPONSOR'S / MONITOR'S ACRONYM(S)

OUSD(AT&L)

11. SPONSOR'S / MONITOR'S REPORT NO(S).

12. DISTRIBUTION / AVAILABILITY STATEMENT

Approved for public release; distribution is unlimited.

13. SUPPLEMENTARY NOTES

14. ABSTRACT

Defense acquisition has long been criticized for taking too long to field new systems—i.e., the "cycle time." The current "Better Buying Power" initiatives have established shorter cycle time as an important objective. This project investigates how MDAP schedules are set and how they are managed, to provide timely capabilities to DOD forces. The research team reviewed documentation on schedule setting and conducted interviews with personnel in both the requirements and acquisition communities. Six MDAPs were selected for investigation. The team sought to determine what methodologies the requirements community used to set times for when capabilities are needed and how those times affected program schedules. The research team found that the process for setting schedules is highly variable and generally lacking in rigor. Schedules are more of an output than an input. In most cases, that was not a problem in itself—for most acquisition programs "getting it right" is more important than meeting a predetermined schedule unless that schedule is driven by firm, critical operational requirements. If schedule is a strong driver, then the technology chosen for use in the program must be at a high level of maturity.

15. SUBJECT TERMS

Defense Acquisition, acquisition cycle times, acquisition program scheduling, acquisition program requirements

16. SECURITY CLASSIFICATION OF:

a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NO. OF PAGES	19a. NAME OF RESPONSIBLE PERSON
U	U	U	U	52	Phillip Anton

19a. NAME OF RESPONSIBLE PERSON
Phillip Anton

19b. TELEPHONE NUMBER (Include Area Code)
(571) 256-7059